SCIENCE

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THE FRESH-WATER BIOLOGICAL STATIONS OF THE WORLD.*

AWAY back at the beginning of the investigation of minute forms of life, which followed upon the invention of the microscope, or shall I say discovery, for it seems to have been historically an accident, the early students searched the ditches and ponds and lakes for the organisms which constituted the objects of their study. Anton von Leeuwenhoek, whose name is familiar to you as one of the most zealous early workers among microscopic objects, enriched science by a long series of new organisms of this character. Roesel von Rosenhof, whose careful investigations on various fresh-water animals, published under the title of 'Insect Diversions' are still standard sources of information concerning the habits and structure of these forms, together with Swammerdam, Trembley, O. F. Müller, and a whole host of others, devoted their attention almost exclusively to the fresh-water fauna. But this movement seems to have culminated with the appearance, in 1838, of Ehrenberg's famous volume 'The Infusion Animalcules as Complete Organisms.'

Extended investigations had already impressed zoologists with the richness of the marine fauna. Numerous animal groups of common occurrence in the sea were apparently entirely wanting in fresh water, and the astounding richness of the sub-tropical and tropical oceans with which the European investigators came early in contact on the shores of the Mediterranean, and in the expeditions to the new lands of the Tropics, entirely over-

*Annual address of the President before the Nebraska Academy of Sciences at Lincoln, November 25, 1898.

shadowed the life that had hitherto been found in pond or ditch. It is, in my opinion, also no small factor that many of the marine forms which were brought to the attention of scientists were dazzling in their beauty of form and in the brilliancy of their coloring. The quieter, more unassuming forms of lacustrine life in temperate regions could make no corresponding impress on the minds of the observers. So the scientific world went to the sea-shore for study and everywhere along the coast of Europe, and even in the islands of the Tropics were to be found the vacation resorts of scientists.

This diversion of attention from the study of fresh-water life was undoubtedly aided by the fact that fifty years ago all centers of education and investigation were comparatively close to the ocean, and so it was easy for the scientist to reach the point, where, as he had learned from the reports of others, life was most abundant and varied, and at the same time, appealed to his æsthetic sensibility as nothing did that he saw about him. The concentration of interest on the life of the sea led to the foundation of marine stations, among which that at Naples was the first in point of time, as it always has been and is today, first in point of strength. But the development of educational institutions through the large continental areas and the limitations which their location imposed upon investigators connected with these institutions, together with the natural efforts of man to find a field for investigation which should afford him a better chance than already overcrowded territory, have led again to the investigation of fresh-water life. So it was that Fritsch, in Bohemia, entered upon lacustrine investigation as early as 1871, while about the same time Forel, in Switzerland, was carrying on those studies published between 1874 and 1879 in a series of papers on the 'Fauna of the Swiss Lakes' culminating in the crowned memoir of the Academy of Sciences on the 'Abyssal Fauna of the Swiss Lakes,' that brought to the knowledge of the scientific world a hitherto unsuspected type of existence and offered a new and enticing field for investigation.

It was also in the same year, 1871, that Stimpson, one of the enthusiastic members of the old Chicago Academy of Sciences, conducted some dredging expeditions in the deep water of Lake Michigan, while about the same time Hoy, Milner and Forbes entered upon investigations at other points on these same lakes. The Chicago Academy and its collections, together with valuable manuscripts of Stimpson, were destroyed in the great fire, the U. S. Fish Commission, under whose auspices the work of Hoy and Milner was inaugurated, did not pursue further the investigations on the lakes, and for years Forbes was the only investigator who occupied himself in this country with the study of lacustrine life. To his work and influence we owe beyond a doubt in our own country the awakened interest in limnobiology, and under his direction also was established the first general fresh-water biological station on this continent, of which more in another connection.

The impulse toward the investigation of fresh-water life which was inaugurated by these men, gradually attracted to itself workers, slowly at first, but approximately a decade ago, with a sudden start the ranks of such were rapidly filled up. An enormous number of ponds and lakes, large and small, scattered over the surface of the continents, afforded an almost unlimited field for investigation, and many early studies were, to say the least, decidedly desultory. There were few workers who were content to confine themselves to a single locality, or to a well-defined problem. A scanty collection was made to serve as the basis of a faunal list supposed to charac-

terize the body of water in question, and the enumeration of species was regarded as the *ne plus ultra* of many investigators.

Like the spiritless systematic zoology, which, in the work of many minor investigators, followed upon the example set by the great Linnaeus, so lacustrine investigators in considerable number, were apparently satisfied to describe, as the results of brief sojourns, the fauna of a lake or lake regions, or, perhaps, even from a couple of vials of material collected by some rich patron in the course of a journey around the world, to discuss monographically the fresh-water fauna of the Fiji Islands, for instance. Under such circumstances there could be no biological study. The chief aim seemed to be to cover as much ground as possible in a short time. And what Lauterborn said five years ago is even truer today in the light of our more extended experience: "For the question as to the distribution of organisms, the methods so cherished even up to the present day of fishing in the greatest possible number of lakes (which recalls, in many respects, the chase after new summits on the part of our modern high climbers—*Hochtouristen!*), really have only limited claim to scientific value, since through them but a very incomplete picture of the faunal character of a water basin can be obtained."

The earlier investigators whose work has already been mentioned, Fritsch in Bohemia, and Forel in Switzerland, had been pursuing a single problem or investigating a limited locality for nearly twenty years, and they were among the first to emphasize the necessity of a modification of the prevalent tendency, and of a more formal character for lacustine work, if valuable scientific results were to be expected from it. Forel was first to publish, in outline, a plan for the precise formal investigation of a body of water, in which emphasis was laid upon the necessity also of continuous and extended investigation, before satisfactory conclusions could be hoped for. This programme has suffered some modification in detail at the hands of various students, but, in its general features, remains the aim and desire of workers everywhere. With the appreciation that such work must needs be formal, continuous and extended, came naturally the desire that stations of a permanent character should be established at various points for the realization of the idea. And the first of these that were founded were of a general character, concerned with the biological investigation of water as a problem of general scientific interest and importance.

But almost immediately other influences made themselves felt which have led to the extension of the general idea along particular lines of economic importance. Improved methods of fish catching and larger demands for fish food had brought various countries to the point where the drain on this kind of food supply was becoming very evident. The fish were being destroyed more rapidly than natural means could restore their numbers, and it was felt that something must be done by governmental agency to replenish the depleted waters. The first expedient of collecting and keeping under satisfactory conditions large numbers of fish eggs until they should be hatched, and the young fry distributed through the waters, was not so successful as had been hoped. The problem was too large to be attacked in such a superficial manner, and the further knowledge, which it became clear was absolutely necessary for proper handling of the question, must needs be sought through some means for the investigation of the conditions and determination of the steps necessary for the solution of the problem, and for carrying into effect the measures which might afford the desired relief. This led, first in Europe, to be sure, in connection with private enterprises for fish culture, to the establishment of bio-

logical experiment stations with the fish hatcheries, very much as chemical laboratories are now necessary adjuncts of various manufacturing interests, or agricultural experiment stations are connected with the higher development of agricultural possibilities. There is, however, a still further demand which has led to the formation of institutions of the general type which we are considering. The water supply of our cities has always been a serious problem, and one of increasing interest in connection with crowded conditions in the more thickly settled countries of the world, and the biological examination of the water, undertaken of necessity, has led to the organization of biological laboratories connected with the water systems of great cities, both on the continent, and in our own country.

Having thus discussed the causes which have led to the establishment of limnobiological stations, we may now consider, briefly, the types which they present, and the particular results which may be expected from a given sort. Of course all probable variations may be found, and it is difficult to make any classification which is complete or even just, and yet, for convenience, we may divide these enterprises into a few great groups, recognizing the fact that certain of them do not belong singly to any one class, but combine features of different types. But before outlining this classification, let me say that I do not regard the existence or non-existence of a building or structure devoted to the purpose of investigation as a necessary mark of a biological station. Some of the most valuable contributions to general and special questions in this field have come from investigators or groups of investigators who have had no abiding place, while, on the other hand, stations well equipped with buildings and apparatus have in some instances, so far as can be ascertained, contributed nothing even after several years' existence, to the progress of scientific knowledge. Material equipment is valuable, and, in general, conduces to better results, and yet it is the results themselves which finally determine the character of any enterprise and the position which it should hold in the esteem of the world.

For the purposes of this discussion I propose dividing biological stations into, first, individual resorts, second, periodic resorts, and third, permanent stations. Individual resorts are such as are characterized by the work of one or more individual investigators, working for the most part independently, and solving their problems by virtue of their individual investigations. There are, of course, a large number of such places where some investigator has made sporadic or single efforts at the determination of the faunal character of a water basin, or has paid a number of occasional visits to such a locality for the same purpose. On the whole, these stations have accomplished comparatively little, although we find striking contradictions of the general statement.

They may also be of a more regular and definite character, and some of these personal investigations have been most valuable in extending our present knowledge of fresh water life. It may be noted here that the permanence or regularity which contributes to the success may be either in the location of the point at which the investigations are carried out, or in the definiteness of the purpose which is followed; thus Imhof's investigations on the pelagic fauna of the Swiss lakes were permanent in their value, and Zschokke's investigation of the biological character of elevated lakes carried on at numerous points in the Alpine chain, has resulted in fundamentally important contributions to the lacustrine fauna of high altitudes. Yet neither of these was at all confined to a single locality, though limited by a definite purpose.

Periodic resorts are those to which groups

of individuals are accustomed to go for a certain portion or season of the year, most commonly for a vacation period in accordance with which they are denominated summer or winter laboratories. The larger number of the investigators tends towards securing a more complete idea of the biological problem as a whole, so that the results obtained from such stations are of evident value. Yet, at the same time, it must be noted that they are distinctly inferior, even to many individual resorts, since during the larger portion of the year no investigations are carried on and the results obtained are necessarily partial and incomplete in their character, and hence unavailable for the decision of the broader and more fundamental biological questions.

Permanent stations are those at which operations are conducted throughout the entire year by a definite corps of observers. The continuity of their work renders their results valuable for the decision of general biological problems, and, at the same time, the permanent force which, in part, at least, is indispensable in such an institution, implies that the undivided attention of the observer is devoted to these problems; from this we may then expect justly that greater results will be obtained than in the case even of the best of individual resorts, since the investigators who are carying on operations at these are, so far as I know, without exception, connected with educational or scientific institutions which demand at least a part of their time, and to that extent divide their interest and their energy.

It is furthermore clear from what has been previously said that such permanent stations are of two distinct classes. First, those which may be denominated general, even though their work is of the greatest value for special purposes, and second, those which are distinctively technical by virtue of their association with specific enterprises.

It is but natural that the different continents are very unequally represented with regard to the number of stations that have been established upon them, and with respect to the knowledge that has been gained in reference to their fresh-water fauna and flora. Thus, our knowledge of the Australian fresh-water fauna is confined, at present, to the report of collections made by travelers, and to the investigation of specimens raised by Sars from dry mud which had been sent to him. Of Africa we know that fifteen years ago an expedition brought word from Lake Tanganyika that while rowing across its waters they encountered swarms of jelly-fish, while many of the gastropod shells which were brought back with them showed, in an equally striking way, their marine character. These reports have been confirmed by an expedition that has just returned, and the strikingly marine complexion of the fauna of the lake can hardly be doubted. This appears all the more strange since collections made at Lake Nyassa, which lies decidedly nearer the sea, show nothing but what is specifically lacustrine. Such facts point, of course, to the importance of the African fresh-water stations of the future.

From various lakes of Asia, all the way from Ceylon to Siberia, numerous more or less extensive collections have been made by travelers, though there is hardly anything sufficiently extended to warrant the statement that a station has been located, even for a limited time, at any point, especially since the collections have not been investigated by men who had made them, but have been turned over as alcoholic material to European investigators for study. We do know, however, that Lake Baikal, which is situated almost in the center of the continent, harbors a rich molluscan and crustacean fauna that is characteristically marine in its form, and is further distinguished by possessing many sponges clearly of marine type, and at least one species of

seal (Phoca), a genus which is typically oceanic. A discussion on the meaning of these features lies far from the purpose of the present paper, but certainly such facts do point out most strikingly that the field of limnobiological investigation is not lacking in topics of extreme interest.

From South America reports concerning the fresh water fauna are perhaps most scanty of all. Frenzel, a German investigator who lived many years in Argentine Republic, has published some interesting studies made while there on the Protozoa; a few isolated notices of the lacustrine fauna from various regions complete the list.

From these statements it is apparent that the work done thus far outside of Europe and North America is exceedingly limited, and that for our judgment of the results in formal limnobiological investigations, we must look to the laboratories of these two continents. Among all European countries, Switzerland has furnished perhaps the greatest number of investigators and stations for limnobiology, together with the most extended and valuable results, although even yet there is not in that country, so far as I can ascertain, a building exclusively devoted to the purposes of this investigation. First and foremost among these investigators may be mentioned Forel, of the University of Lausanne,* to whom reference has already been made. His investigations have been carried on for more than thirty years on Lake Geneva; to him we are indebted for the first knowledge of the abyssal fauna of a fresh-water lake, for the first extended program and plan for the investigation of such a lake, and for the first effort towards the realization of such a plan, which finds its full expression in his 'Lac Léman,' a monograph at present in the course of publication; the volumes which have appeared thus far treat of physical, chemical, and meteorological conditions on the lake, and are to be followed by others which will complete, with the flora and fauna, the entire limnologic investigation. The series will make a magnificent and permanent contribution to lacustrine investigation, and will serve as a model for the work of all times.

* In a sense the laboratory of the University, which is located near the shore of the lake, is the building of the station, as in Wisconsin, mentioned below.

The work of Zschokke, professor at the University of Basel, has been directed as already mentioned towards the elucidation of the faunal aspect of elevated lakes. It has been carried on through many years at differents points, including the lakes of the Jura to the westward, as well as those in various regions of the Alps proper, and his papers on the fauna of elevated lakes contain the only general statement of the problem as well as of the characteristic features of such localities that has yet appeared. Lake Constance has been the scene in recent years of the work of numerous investigators under the guidance of an association for the investigation of the lake, which has its headquarters at Lindau. The published accounts of these investigations have thus far been preliminary in character, and I am unable to learn whether there is a building devoted to the purposes of investigation, and whether the work is carried on throughout the entire year.

This lake was the scene of early investigations by Weismann in 1877, and the present work which was inaugurated about 1893 is under the direction of Hofer, of the University of Munich.

To Bohemia belongs the honor of having had the first definite building for lacustrine investigations in the form of the Bohemian Portable Laboratory which was constructed, in 1888, under the direction of Professor Fritsch, of the University of Prague. Reference has already been made to the early work of this investigator, who, in 1871,

reported to the Academy of Sciences, in Prague, the results of the investigations of Black Sea, a small body of water in the Bohemian forest, with reference to the distribution of animals according to the depth of the water and their relation to the shore. These investigation which were extended to other lakes in the same year, are, I believe, the first at least to be recorded that were carried out in this way. It was, however, in 1888 before Fritsch succeeded in obtaining funds for a small portable zoological laboratory having some twelve square meters of floor surface. The station remained at its first location four years, and was replaced by a permanent structure when it was removed to another locality. This portable laboratory has been regularly visited at brief intervals of time by the director and his associates in the three localities at which it has been situated during the last ten years, and the contributions from this work constitute most valuable studies on the lacustrine biology of Bohemia.

In Finland there exists the laboratory of Esbo-Löfö, on one of the small islands which, though primarily a marine station, is so favorably located with reference to bodies of fresh water that it has devoted a considerable portion of its energy to the investigation of the fresh water fauna with valuable results. This laboratory has been maintained since 1895 under the direction of Professor Levander. Its contributions are published in the 'Acta Societatis pro Fauna et Flora Fennica.' One of its workers, Dr. Stenroos, has for several years individually visited Lake Nurmijärvi, one of the small inland lakes with which Finland is so plentifully supplied, a body of water, which though it is about two and five-tenths kilometers in length by one in width, has a maximum depth of only one meter; he has given us a very complete faunistic and biologic study of its life.

Russia has recently established a station on Glubokoe Osero, or Deep Lake, in the Province of Moscow, under the patronage of the Imperial Russian Society for Fish Culture. The station is under the direction of Professor Zograf, of Moscow University, whose contributions to lacustrine investigation, have been made known especially in a paper on the lake regions of Russia from the biologic standpoint, which was read before the International Zoological Congress in 1893. I infer that the station is a permanent one, though probably of technical character, although precise information on these points has not been obtained. Hungary has maintained for some years a lacustrine station on Lake Balaton, one of the largest fresh-water bodies of Europe, having an area of over 266 square miles, though its maximum depth appears to be only 11 meters; it is surrounded by enormous marshy areas which give thus varied conditions for the development of life. Several parts of the report on these investigations have already been published. In France there exists a lacustrine laboratory near Clermont-Ferrand, which seems to have been organized in 1893; no reports or contributions from the station are recorded in the bibliographical records. At Paris, Drs. Richard and de Guerne have investigated collections from a large number of lakes not only in France and neighboring countries, but even from Algeria, Syria, the Azores and other points, and have published valuable contributions on the distribution of fresh-water crustacea, as well as systematic monographs of various groups.

In Germany all types of stations are represented, as might be expected, from the importance of scientific study in that nation. Individual investigators, not a few, have examined various lakes or lake regions, most prominent among them being undoubtedly Apstein, whose studies on Holstein lakes have extended over many years, and whose work on fresh-water plank-

ton is the first general statement of the problems and of the methods used by Hensen in the investigation of the marine life with such success, and by Apstein first applied to lacustrine investigation. Probably the best known fresh-water station in the world is that on Lake Ploen also in Holstein. This was the first permanent general fresh-water station to be established in the world. It owes its inception to the energy of its present director, Dr. Zacharias, whose plan was to establish for fresh water an institution similar to the Naples marine biological station. The station opened in 1891, and since that time it has been in continuous operation, and has afforded opportunities for investigation to a large number of scientific workers both German and foreign. It is the most pretentious of all fresh-water stations, having a building two stories in height, with numerous laboratory rooms and equipped with abundant apparatus for collecting and investigating. From it has been published yearly, since 1893, a volume of studies, and the director has also contributed largely to other journals on these problems. Two other stations in Germany owe their inception to the fishery problem, and have for their purpose more particularly the investigation of those limnologic questions which deal particularly with the life of the fishes. One of these is located at Müggelsee, near Berlin, and is conducted under the auspices of the German Fishery Association. The other, at Trachenberg, is under the auspices of the Silesian Fisheries' Association. Both have made important contributions to the biological questions concerned in fish culture.

All the North American stations which are known to me lie within the limits of the United States, and they represent all the various types of such institutions. A considerable number of workers have reported isolated investigations of lakes in all parts of the country from Maine to California. Among the most important of these occasional observations are those made by Forbes on the fauna of elevated lakes in the Rocky Mountains. The observations which he has recorded were made in the course of a preliminary investigation of these lakes by the United States Fish Commission, and constitute the only information on record with reference to the lakes of the country west of the Missouri river. There are but two localities which may be listed, however, as individual resorts sufficiently regularly visited to entitle them to more particular mention in this place. Green Lake, in Wisconsin, has been carefully studied by Professor Marsh, of Ripon College, and his work has yielded valuable information with reference to the vertical distribution of the crustacea and with regard to the deep water fauna of the lake. Here he was able to confirm the observation of Stimpson, on Lake Michigan, that there are found in the deep waters of our large lakes crustacea of a purely marine type. At Lake Mendota, in Wisconsin, on the shores of which is located the State University, a careful investigation, extending over a very considerable number of years, has been carried on by Professor Birge of the University. The results which he has obtained with reference to the distribution, both vertical and seasonal, have been published by the Wisconsin Academy and are not only the most extensive, but beyond all comparison the most precise investigation which has been made on this problem.

Of course, in one sense, this station has no building, but the scientific laboratory of the University, standing within a stone's throw of the shore of the lake, affords opportunities which are not surpassed at any fresh-water station in the world.

Quite a number of periodic resorts of the type of summer laboratories are to be found in various parts of the country. Some of these are merely summer schools, such as

the biological laboratory of the Chautauqua College of Liberal Arts, on Lake Chautauqua. Others are both for teaching and for investigation, while only a small number are exclusively devoted to the investigation of limnologic problems from one standpoint or another. The University of Minnesota has maintained at Gull Lake, near the center of the State, a laboratory for summer work by members of the University, and for the prosecution of the natural history survey of the State under the direction of Professor Nachtrieb, of the University. The State University of Ohio has conducted, since 1896, a lake laboratory near Sandusky, on Lake Erie. It occupies one of the State fish hatcheries, and is supplied with the necessary apparatus by joint action of the University and State Fish Commission. Its purpose is to afford a convenient point of work for the members of the University, and also to aid in the prosecution of the State Biological Survey, which is being carried on by the Ohio Academy of Sciences. The immense stretches of shallow water, marshy regions, and protected areas, together with the varied character of shore and the open lake within easy reaching distance, serve to make Sandusky perhaps the most favorable place on Lake Erie for the study of the fresh-water fauna and flora. The station was closed a year ago, owing to the death of the Director, Professor Kellicott.

In 1895 the University of Indiana opened a Biological Station on the shore of Turkey Lake in the northern part of the State, under the direction of Professor Eigenmann of the University; a constantly increasing number of students has visited the station each summer. The majority of them have been teachers of the State engaged in the prosecution of work to equip them for their teaching, but others have also assisted in carrying out a general survey of the lake fauna and in the collection of material to illustrate annual variation and associated problems. For comparison, collections have been made from adjacent lakes connected with other water basins. In the coming year the station is to be moved to the shores of Winona Lake, some 18 miles from the present location, where two building are to be constructed for its use by the Winona Assembly. The contributions from the laboratory have been published in the Proceedings of the Indiana Academy.

For a number of years the Michigan Fish Commission maintained a force of a few scientific investigators and assistants in conducting a biological examination of the inland lakes of the State, under the direction of Professor Reighard of the University of Michigan. In 1893 it was determined to transfer the seat of operations from inland waters to one of the Great Lakes, and by virtue, both of its convenient location and of its importance as a famous spawning ground of the lake fish, which had, however, almost ceased to visit it, Lake St. Clair was decided upon as the locality for the first year and the laboratory was located on a small bay at the northwest shore of the lake. The party consisted of half a dozen scientific workers whose attention was exclusively devoted each to his particular field, and the results of the survey were published in bulletins of the Michigan Fish Commission. In 1894 the station was moved to Charlevoix, a famous fishing region on the eastern shore of Lake Michigan, and, owing to the absence of Professor Reighard, in Europe, I was requested to take charge of the work. The scientific force and the methods of work were similar to those of the preceding year, but the location brought us in contact, not only with shallow waters, but also with the deeper regions of Lake Michigan, and the party made investigations and collections of a precise character in the deepest fresh water which has as yet been investigated by such methods. The

results of the summer's work were published in a bulletin of the Commission. Unfavorable financial conditions compelled the suspension of the work on the part of the Michigan Fish Commission, but American investigators owe much to the impetus which has been given to such work through their agency.

For many years the U. S. Fish Commission has been urged to establish on the Great Lakes a biological station similar to that which has long been maintained on the ocean, at Woods Hole, Mass. Finally, a year ago, a prelininary survey was undertaken with a view to deciding the advisability of such a movement and Professor Reighard was requested to assume the leadership of the enterprise. The U. S. Fish Hatchery at Put-in-Bay, a small island in the center of the west end of Lake Erie, was selected as the seat of operations and a party of scientific workers spent two months in studying the fauna and flora of the adjacent waters. It is to be hoped that this work may develop into a permanent experiment station on the Great Lakes.

Among permanent American stations of a technical character, the Experimental Filter Station of the Massachusetts Board of Health, located at Lawrence, is the best known as it is also, perhaps, the most famous of its kind in the world. It has been in continuous operation since 1887 and has conducted extended experiments on the biological examination of drinking waters; the methods worked out in connection with them are now standard for such purposes. Similar technical laboratories are in operation in Boston, Lynn, Worcester and other cities; but in most of them the biological examination of waters is only a secondary function. The Mount Prospect Laboratory, organized recently in connection with the Brooklyn Water Works, and placed under the direction of Mr. G. C. Whipple, whose contributions to limnobiologic questions are well known, is more particularly devoted to the investigation of questions connected with the character of the water supply. Numerous samples taken from all the sources of the city's supply are subjected each week to physical, chemical, microscopical, and bacteriological examinations, and the quality of the water controlled thereby, since the reports made to the chief engineer serve to guide him in the choice of the sources from which the water is drawn. The results of such studies are also of great importance in general limnologic questions.

The University of Illinois was extremely fortunate in having associated with it, by statute, a state laboratory of natural history which has been engaged for many years in a natural history survey of the State. Under the direction of Professor Forbes, whose pioneer work on the lake fauna has already been noted, particular attention was paid to such questions as the food of fresh water fishes, and the distribution of various groups of fresh water organisms, so that both by preliminary work, and in the person of its director, the state laboratory was peculiarly fitted for the successful inauguration of an Illinois Biological Station which became possible under state grant in 1894. The laboratory secured a permanent superintendent in the person of Dr. Kofoid a year later, and work has been carried on continuously by a permanent force since that date. The laboratory was unique in its inception since the director, Dr. Forbes, conceived the idea of locating it on a river system rather than as all previous stations on a lake, and it was not only the first in the world, but is yet the only station which has peculiarly attacked the problems of such a system.

The Illinois river and its dependent waters were selected as the field of operations and Havanna, Ill., as the center of work. The river here presents in its cut-offs, bayous, shallow, marshy tracts, sandy

areas with wooded margins and regions of spring fed waters, and with the enormous extent of land covered at high water, a variety of conditions which it must be confessed could not be surpassed, and hardly equalled elsewhere. The abundance and variety of the flora and fauna, both in the higher and lower forms of life, demonstrate the good judgment exercised in the choice of locality. A noteworthy feature in the equipment of this station, and so far as I know, one that is unique, is the floating laboratory which enables an easy transfer of operations to other points, where work can be carried on for comparison or contrast, with equipment and environment as satisfactory as that which exists in a permanent building, but with the flexibility and facility of movement which characterizes field studies. The work has been conducted uninterruptedly for more than three years, and the results include studies on the insects and their development, on the earthworms, on the Protozoa and rotifers, on various groups of crustaceans and general investigations on plankton methods and on the distribution of the plankton, while some work has also been done on the plant life of water. These studies have been published in the Bulletin of the Illinois State Laboratory of Natural History.

Let us consider, in conclusion, the function and future development of these institutions. It is perfectly clear that the work of the different types of fresh-water stations will vary somewhat with the class, and Zacharias has outlined carefully the differences in the work of the fixed and of the movable stations. But these are, after all, minor differences. All stations, whether fixed or movable, have really three objects: teaching, investigating, experimenting, objects which may be subserved directly or indirectly, or in both ways, by each one of them. It is unquestionably true that the tendency within recent years has been to make the university trained scientist a laboratory man, unacquainted with work out of doors and among living things. This has reacted unfavorably upon his teaching powers, and thus indirectly upon the entire school system. Not that subjects in natural history are not better taught in our secondary schools than they were twenty years ago, when, in truth, they were hardly taught at all, but that the naturalist to-day is not trained as an outdoor observer and is little capable of handling himself and his work in a new environment. As Forbes says: "It is, in fact, the biological station, wisely and liberally managed, which is to restore to us what is best in the naturalist of the old school united to what is best in the laboratory student of the new." Thus, both through the influence of the investigators in the case of those stations which do not carry on directly any educational work, and through the teaching of those which do conduct summer instructional courses, new life will be instilled into the teaching of natural history throughout our country.

In the second place, the fresh-water station is a center for investigation with all its stimulating effects on the individual thus brought in contact with problems of Nature and efforts for their solution, and in the contributions to the advancement of knowledge which are the fruits of a careful work on the part of its attachés. All that has been said of the advantages of marine stations applies equally well to fresh-water laboratories, together with the added advantages that their accessibility brings these advantages to considerable regions which would otherwise be entirely without them by virtue of their distance from the sea. It is unnecessary that I should emphasize further this phase of the question, or dwell upon the greater simplicity of biological conditions in fresh-water over those which exist in the ocean. These factors have been forcibly presented by many writers.

Finally, the fresh-water station should be above all things an experimental one, and in this direction the most valuable results are to be looked for, both from the general scientific and from the technical standpoint. To the scientist, this needs no demonstration; but it is essential that the importance of such work, especially for fish culture, be more widely understood. The advance in agricultural methods in the United States is unquestionably due in large part to the development of a splendid series of agricultural experiment stations in which agricultural problems have been subjected to intensive experimentation. Contrasted with this, conditions in fish culture present almost the opposite extreme. Fish eggs have been hatched in enormous numbers, but what is known of their subsequent history or what has been done to insure the safe development to maturity of the fish? Present methods have reached their limit and the subject must be attacked from a different standpoint. Fish culture should receive by the liberality of state and nation the same favors that have been extended to agriculture, the use of permanent and well-equipped experiment stations where trained workers shall devote their time and energy to the solution of its problems. Thoroughness and continuity are essential, for these problems really deal with all conditions of existence in the water. Of what does the food of each fish consist, where is it found and in what amount, how may it be increased and improved; to what extent and how can the number of fish be multiplied, and how far is this profitable; what are the best kinds of fish and what new varieties can be produced? These are a few of the many questions to be solved.

The problems outlined are indeed vast, and yet we may be confident that their solution lies easily within the power of the human intellect, for they are all paralleled in the history of the agricultural development of the race; and man, relying upon his success in the past, may go forward with supreme confidence to the attainment of their solution in this new field.

HENRY B. WARD.
ZOOLOGICAL LABORATORY,
THE UNIVERSITY OF NEBRASKA.

BRUNISSURE OF THE VINE AND OTHER PLANTS.

SINCE the publication, in 1892, of the papers by Viala and Sauvageau describing Brunissure of the Vine and the California Vine disease as due to *Plasmodiophora vitis* (Viala et Sauv.) and *P. californica* (Viala et Sauv.) much interest has been manifested in these supposed new parasites. F. Debray and A. Brive in Revue de Viticulture, 1895, claimed to have found the parasite in a large number of plants belonging to numerous families and genera. They made a new genus for the organism calling it *Pseudocommis vitis*. By far the best work, however, has been done by Viala and Sauvageau. A full discussion of their work with bibliography may be found in 'Les Maladies de la Vigne, par Pierre Viala, Troisième édition 1893, pp. 400–413. Any one who has observed for himself the peculiar structures described would most likely decide at once that they must belong, or be at least closely related, to the genus *Plasmodiophora*. The peculiar vacuolate plasmodium-like structures may be best studied, following the directions of Viala (in Maladies de la Vigne), by slowly clearing the sections or tissues in dilute eau de javelle. The protoplasm of the host cell is said to be dissolved, while that of the plasmodes remains for a long time unattacked. The plasmodes may then be colored with iodine or other stains, bringing out their structure very sharply. I have recently repeated these experiments very carefully and find everything described by Viala and Sauvageau in *Vitis* and also as described by

Debray in other plants. In fact, the phenomena can be produced in all plants so far as I have examined, whether healthy or diseased, especially in cells containing chlorophyll. I obtained the plasmode structures readily in leaves and stems of *Vitis*, *Lilium harrisii*, *Tobacco*, *Tomato*, *Rose* and *Hyacinth* and in *Spirogyra* cells. If one watches the action of eau de javelle closely under the microscope a slight plasmolysis of the cells is first seen which may increase or afterwards disappear. The chloroplasts swell and become colorless and unite with each other, and usually with the rest of the protein, into an amorphous mass almost transparent. This mass after a time contracts into a single vacuolate plasmodium-like structure or into several such structures in each cell. These become highly refractive and remain without much change for several hours or disappear, according to the strength of the reagent. In this stage the plasmodes may be coagulated with alcohol or iodine and stained and permanently mounted in glycerine containing alcohol or iodine. If dilute glycerine or pure water is added before coagulation the plasmode structures swell, lose their high refraction and become amorphous. In coagulation these formations behave like any albuminoid substance. Their formation, however, is entirely different from the separation of active albumen in the cell by the addition of an aqueous solution of caffeine as described by Dr. Loew. This difference will be discussed in a fuller paper now in preparation. The action of the eau de javelle is most likely an oxidation in the presence of an alkali. Changes of the kind described are not produced by a mixture of sodium chloride 5% and sodium hydrate 1% or of either of these acting alone. A phenomenon quite similar, however, is produced in the Lily if the tissues are first soaked in peroxide of hydrogen till discolored and sections then mounted in sodium chloride 5% and sodium hydrate 1%. The cell contents then quickly swell and become amorphous, and highly refractive plasmode structures separate out. These gradually disappear if not coagulated with iodine or alcohol. In the latter case they behave as do the similar structures produced by the eau de javelle. If the theory is correct that these changes are produced by an oxidation of the chloroplasts and other cell contents in an alkaline medium it explains why such structures, or a reticulate form of them, usually appear in cells which slowly die and become brown around the punctures of aphids in the leaf of the Bermuda lily. Numerous tests made by the writer have shown that plants which react in this manner to aphis punctures contain much larger quantities of oxidizing enzyme than plants which do not so react. The presence of the substance injected into the wound by the aphis probably causes the neighboring cells to increase still more in oxidizing enzyme until the presence of the latter in excessive quantity destroys or oxidizes the chloroplasts. The cell slowly dies, and the rest of the cell contents may then be attacked. A brownish shrunken amorphous mass is left. On the addition of dilute potassium hydrate or sodium hydrate to sections from such spots the oxidized protoplasm in the cells which have turned brown swells up and becomes a reticulated or vacuolate mass, such as is often obtained with the eau de javelle or the peroxide of hydrogen and sodium hydrate. It is quite likely, therefore, that plasmode structures would be formed by an alkali in any cells that had previously become oxidized either from the presence of oxidizing enzyme in themselves or from any other cause. These observations indicate quite decidedly that the supposed Plasmodiophora vitis or Pseudocommis vitis are nothing but microchemical reactions, brought on by oxidations and the influence of an alkali upon the en-

tire protein contents of cells, especially upon chloroplasts.

A complete account of the work with illustrations will be published soon.

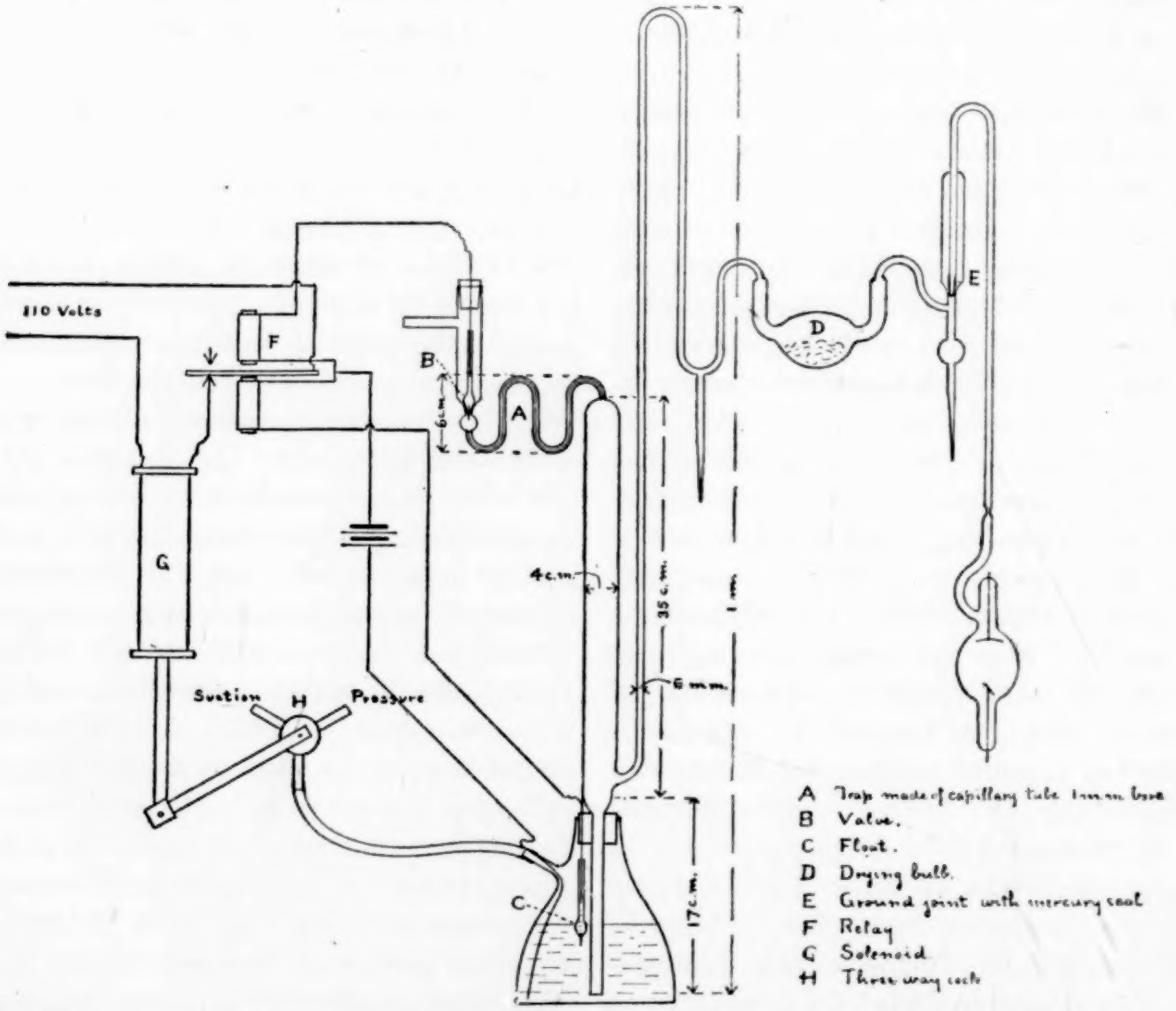
ALBERT F. WOODS.
DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY, U. S. DEPT. AGRICULTURE.

AN AUTOMATIC MERCURY PUMP.

ALTHOUGH there is nothing especially new in regard to the pump proper, the method of electrical control may be sufficiently novel to warrant a brief description.

flask filled with mercury. A tight joint is made between the flask and pump by a rubber stopper. This stopper also serves as a flexible support for the body of the pump. The exhaust tube is sealed into the pump just above the point at which the pump passes into the flask. The arrangement is best shown by the figure.

The tube to be exhausted is attached to the pump, through a drying bulb filled with anhydrous phosphoric acid, by a simple ground joint with a mercury seal. The valve at the top of the pump is ground to



The pump proper is a modification of a common form of Geissler pump. It consists of a long glass tube, about $1\frac{1}{4}$ inches in diameter, which has a mercury trap and a small glass valve at the top. The bottom of the tube is drawn down and dips into a

fit its seat and so weighted by filling with mercury that it closes, leaving sufficient mercury above it to form a tight joint. Dimensions which give very satisfactory results are shown on the figure. Suction is applied permanently to the top of the pump

above the valve. The mercury in the pump is raised or lowered by applying atmospheric pressure or suction to the flask. The suction necessary to operate the pump is obtained by a small water-jet pump giving a vacuum of about 28 inches. A pump with the valve alone will work fairly well, except that occasionally, when the quantity of air taken out at each stroke becomes small, a little bubble will cling to the valve and refuse to pass out of the pump. To avoid this, a trap is added below the valve to prevent any air which might fail to pass the valve from returning to the pump.

The only requisite to make the pump automatic is to have some means of controlling a three-way cock which will apply either pressure or suction to the flask. This control is obtained electrically by making and breaking a circuit in the valve at the top, and in a float in the flask at the bottom. A permanent electrical connection is made with the mercury in the flask at the bottom. A platinum wire sealed into the tip of the valve serves to connect electrically the mercury in the valve with that in the pump. An iron wire dips into the stem of the valve and serves as a final contact. The mercury rising in the pump first makes contact with the inside of the valve through the platinum wire. As it continues to rise the valve opens floats and completes the circuit by the iron wire. It will be seen that the final contact is made in the valve, and any sparking that may occur can in no way foul the mercury in the pump. When the mercury in the pump reaches its lowest level a float in the flask similar to the valve at the top closes another circuit. These two circuits control a relay which in turn controls a solenoid connected to the three-way cock. The solonoid is wound for 110 volts and takes only a small current. One or two Leclanché cells are sufficient for the relay. The electrical connections are shown in the figure.

A pump of this form has been in use at the Massachusetts Institute of Technology for over two years, and has proved very satisfactory. It works quickly, and will give high Crookes vacuum without trouble.

In starting the pump, the pump and whatever may be attached to it are first exhausted by the water pump to about two or three inches' pressure. For the first few strokes, which are make by hand, the mercury is allowed to rise only part way in the pump. After this the necessary electrical circuits may be closed and the pump will take care of itself. In this way the dangerous hammering of the mercury occurring when the quantity of air taken out at each stroke is large can be avoided.

I am indebted to Mr. C. L. Norton for valuable assistance in developing this pump.

RALPH R. LAWRENCE.
ROGERS LABORATORY OF PHYSICS,
MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

SCIENTIFIC BOOKS.

The Wonderful Century. By ALFRED RUSSELL WALLACE.

As the human mind is more wonderful than anything else that we find in nature, so the greatest and most significant difference between the 'Wonderful Century' and all that had gone before is an intellectual difference.

It is not invention and discovery and the extension of man's dominion over nature, but the establishment of the conviction that we know no limit to this movement, that is the chief distinction of our century.

Among those who have, in our day, guided the thoughts of men to this conviction, future historians will give the highest place to Lyell, and Wallace and Darwin; for no one in our century has done more than they to assure us that the scientific method is adequate; even if successive generations of 'philosophers' still continue to teach that the very top and perfection of human wisdom is the assertion that we know, and can know, nothing.

With modesty which some hold to do him less than justice, Wallace believed that Darwin so much surpassed him in strength and wisdom and in acquaintance with nature that it became his duty to devote his life to the assistance of Darwin in his efforts to extend the province of human knowledge into regions that had been declared closed. The intellectual revolution has come about, nor will the thoughtful permit Wallace's part in bringing it about to be forgotten; nor can we forget the generous devotion which chose the advancement of truth before the natural desire for recognition and distinction. No one can suspect that such a man as Wallace has proved himself will ignore or depreciate the share of anyone in this great work, and few chapters of his book on 'The Wonderful Century' are more interesting than the one in which he touches, very gently and tenderly, upon the part which the 'philosophers' have had in the progress of natural science.

It is one thing to show that there is no logical basis for belief that species are immutable, but it is quite a different matter to show what modifies species. It was by finding out, and not by exposing the weakness in the logic of those who asserted that we never can find out, that Wallace and Darwin passed the bounds where they had been told that natural knowledge ends.

Lamarck, and Chambers, and Herbert Spencer, and many others, even Wallace himself, had shown that there is no reason to doubt that species are mutable; but all had failed to show how the changes take place; and many eminent men of science, as well as the general public, refused to consider beliefs which were as yet beliefs and nothing more.

What educated public opinion was before the publication of the 'Origin' is shown, says Wallace, by the fact that neither Lamarck nor Herbert Spencer nor the author of the 'Vestiges' had been able to make any impression upon it. The very idea of progressive development of species from other species was held to be a 'heresy' by such great and liberal-minded men as Sir John Herschel and Sir Charles Lyell; the latter writer declaring, in the earlier editions of his great work, that the facts of geology are 'fatal to the theory of progressive development.' The whole literary and scientific worlds were violently opposed to all such theories, and altogether disbelieved in the possibility of establishing them. It had been so long the custom to treat species as special creations, and the mode of their creation as the 'mystery of mysteries,' that it had come to be considered not only presumptuous, but almost impious, for any individual to profess to have lifted the veil from what was held to be the greatest and most mysterious of Nature's secrets.

Wallace tells us, 'The Wonderful Century,' p. 139, that after he had studied what had been written, and even after he had himself written about the mutability of species: "I had no conception of *how* or *why* each new form had come into existence with all its beautiful adaptations to its special mode of life; and though the subject was continually being pondered over, no light came to me till three years later (February, 1858), under somewhat peculiar circumstances. I was then living at Ternate, in the Moluccas, and was suffering from a rather severe attack of intermittent fever, which prostrated me for several hours every day during the cold and succeeding hot fits. During one of these fits, while again considering the problem of the origin of species, something led me to think of Malthus' Essay on Population (which I had read about ten years before), and the 'positive checks'—war, disease, famine, accidents, etc.—which he adduced as keeping all savage nations nearly stationary. It then occurred to me that these checks must also act upon animals, and keep down their numbers; and as they increase so much faster than man does, while their numbers are always nearly or quite stationary, it was clear that these checks in their case must be far more powerful, since a number equal to the whole increase must be cut off by them each year. While vaguely thinking how this would affect any species, there suddenly flashed upon me the idea of *the survival of the fittest*—that the individuals removed by these checks must be, on the whole, *inferior* to those that survived. Then, considering the *variations* continually occurring in every fresh generation of animals or plants, and the changes of climate, of food, of enemies always in progress, the whole method

of specific modification became clear to me, and in the two hours of my fit I had thought out the main points of the theory."

If this had been only a fortunate guess it would have little interest, for no one cares to ask whether Empedocles, or Wells, or Mathew, or Darwin, or Herbert Spencor, or Wallace first had this happy thought. It was because Wallace had spent years of hard work in gathering facts and in pondering them that he was able to see that this sudden product of his 'fit' was worthy of further examination, and because he devoted the rest of his life to its application to new discoveries that he is held to be the joint discoverer of the law of Natural Selection.

The origin of species by means of natural selection is now universally accepted as a demonstrated principle. "This," says Wallace, "is, of course, partly due to the colossal work of Herbert Spencer; but for one reader of his works there are probably ten of Darwin's, and the establishment of the theory of the *Origin of Species by Means of Natural Selection* is wholly Darwin's work. That book, together with those which succeeded it, has so firmly established the doctrine of progressive development of species by the ordinary processes of multiplication and variation that there is now, I believe, scarcely a single living naturalist who doubts it. Probably so complete a change of educated opinion, on a question of such vast difficulty and complexity, was never before effected in so short a time. It not only places the name of Darwin on a level with that of Newton, but his work will always be considered as one of the greatest, if not the very greatest, of the scientific achievements of the nineteenth century, rich as that century has been in great discoveries in every department of physical science."

To this we must add that, so long as the 'Origin of Species' holds its place on the shelves of students, close beside it we shall find the 'Malay Archipelago;' for the writer of this review has no doubt that Wallace will be one of those to whom future generations will say: "Friend, Go up higher."

W. K. BROOKS.

JOHNS HOPKINS UNIVERSITY,
BALTIMORE.

The Principles of Bacteriology. By DR. FERDINAND HUEPPE. Translated by PROFESSOR E. O. JORDAN. Chicago, The Open Court Publishing Co. Pp. 455.

American bacteriologists certainly owe a debt of gratitude to Professor Jordan for putting into clear English this valuable contribution to the science of bacteriology of Professor Hueppe, of Prague. Hueppe's contribution to bacteriology in this volume is no ordinary one. The book is not simply a review of facts, but is decidedly original. From the first to the last the author and his opinions are decidedly in evidence. Whether or not one is inclined to agree with him in all his conclusions, no one will question the force of the arguments with which he upholds his opinions.

After giving some general information in regard to bacteria (in which the author accepts the conclusion that the tuberculous bacillus is not a bacterium at all) he deals in successive chapters with the vital phenomena of bacteria, pathogenic bacteria, the cause of infectious diseases, cure by combating the cause, immunity, prevention and history. The chapter upon vital phenomena of bacteria is especially valuable, since it treats, in a comprehensive manner, of the somewhat obscure subject of the chemistry of bacterial poisons and bacterial nutrients.

But the most suggestive part of the work begins with the chapter upon the cause of infectious disease. Here he sets himself in opposition to the school of Koch by denying that bacteria can in any proper sense be regarded as the cause of disease, and especially repudiating the idea that definite species of bateria are the 'specific' cause of 'specific' diseases. No one can question Hueppe's thorough acquaintance with the facts of modern bacteriology, and it seems a little strange that he can hold a position so generally at variance with that of most bacteriologists. But we soon learn that his position is not so different from that of Koch as at first appears, and perhaps not so different as Hueppe tries to make it appear. Hueppe is, of course, fully aware that diseases are produced in animals by inoculating them with certain bacteria cultures. His criticism is simply against the claim that they are the *cause* of the disease and

that definite species cause definite diseases. That they *provoke* diseases he recognizes ; that they *cause* them he denies. His own position is essentially as follows: Disease and health alike are attributes of the activity of living cells.

Health is the result of the normal activity and disease of the abnormal activity of these cells, and it is hardly more correct to say that disease is caused by bacteria than to say that health is caused by their absence. Disease is a process, not an entity, and is really caused by some condition of the living cells which makes them liable to act abnormally when stimulated. No disease can appear in the body except such as are predisposed in the living cells. The bacteria serve as a stimulus just as the spark serves as a stimulus for gunpowder. The spark is not the cause of the explosion, though it may excite it. There is a certain amount of resistance to be overcome before the cells will start to act abnormally, and the bacteria simply overcome this resistance. We are learning to appreciate more and more fully that one animal may be predisposed to a disease while another is more resistant, a fact in itself which shows that we are speaking very loosely when we say that the bacteria cause the disease. According to Hueppe disease is the result of a number of factors of unequal weight. External conditions constitute one factor, the condition of the body cells a second, and the presence of certain bacteria a third. When together they produce disease. Break the chain as one link and there is no disease. The school of Koch has paid attention to one of these links, the school of Virchow to the second, while Petinkoffer is trying to study the third, *i. e.*, external conditions. Hueppe insists that neither one causes the disease, but all three together. Disease is a vital activity, and while bacteria are needed to stimulate it they don't properly cause it.

This conception, of course, largely determines the position which Hueppe takes in the other topics considered. The question of combating the disease by combating the bacteria is only one side of the matter. Prevention involves something more than simply looking after the bacteria. Hygienic measures are misdirected if they look simply toward the destruction of bacteria. The disinfecting mania which developed a few years ago he regards as exaggerated and largely needless. Hygienic measures in the past have been very useful and produced a decided improvement in public health, but this has not been because they have destroyed the 'specific' bacteria. Rarely do we succeed in this object. Sanitariums for tuberculosis pay little attention to the matter of germs. The success has resulted from the fact that hygienic measures and cleanliness, together with fresh air and sunlight, have improved the *general health*, given the cells greater vitality and made the individual less disposed to acquire the disease. They are successful because they have been directed to the second link in the chain rather than the third.

It is a question whether his position is quite so much at variance with generally accepted belief as Hueppe is inclined to think. In denying that distinct bacteria are 'specific' he fails satisfactorily to reconcile this position with the fact that definite species do provoke definite diseases. He fails to make it clear just how the bacteria act to produce distinct diseases if they are not specific. It is a somewhat curious position to assume that the silk worms have always had a special predisposition to pebrine, but that this disposition only appeared when the pebrine organism made its appearance, especially as it appears that all individuals yield to the attacks of this germ. But apparently Hueppe would assume that the animals have had this predisposition to a disease which never had a chance to develop until the proper organism produced the stimulus. Hueppe has perhaps just as truly overdrawn the case from his point of view as Koch did from his own standpoint. But certainly all bacteriologists may read with profit this somewhat new setting-forth of the problem of bacterial diseases, and Hueppe is certainly to be thanked for bringing forward so forcibly the part which the vital activity of the organism plays in the matter of disease. He has certainly done a valuable service in pointing out that the problem of the physician and bacteriologist is to be directed toward the man and not the bacterium.

H. W. C.

The Elements of Graphic Statics. By L. M. HOSKINS, Professor of Applied Mechanics in the Leland Stanford Jr. University. New York, The Macmillan Company. 1899. Revised Edition. Pp. viii + 199, and eight plates.

The character of works under the head of Graphical Statics varies between that extreme of which Cremona's treatise may be regarded as typical, in which the name can be regarded as scarcely more than a peg on which to hang a large amount of theoretical projective-geometry matter, and the opposite extreme, where we may place the work before us, characterized, as it is, by intense practicality and general avoidance of everything of merely theoretic or historic interest. The favorable impression made upon one by the mechanical excellence of Professor Hoskins' book is further confirmed by a careful examination of the text.

Avoiding the error of Culmann in presupposing too much information on the part of his students as to projective relations and graphic methods, the author lays his own foundation on which to build, treating the subject more, however, as a branch of mechanics than of geometry. To this his Part I. is devoted, and it would seem impossible to set forth the fundamentals more clearly and concisely than in the fifty pages devoted thereto.

Familiarity with analytics and the calculus is assumed for the remainder of the work. Bow's convenient system of notation is employed throughout.

Excluding entirely from the book any consideration of structures whose discussion involves the theory of elasticity, the hundred pages constituting Part II. are devoted to the usual problems of beams and of bridge and roof trusses. We have not at hand a copy of the original edition for comparison with the revision, but as Professor Hoskins' preface indicates that the principal changes are in this section we state them in this connection in his own words: "In the present revised edition no change has been made in general plan, and few changes in the treatment adopted, except in the portions relating to beams and trusses carrying moving loads. These portions have been wholly re-written. It is believed that a substantial improvement has been made upon the methods hitherto used, particularly in the criterion for determining the position of a given load-series which causes maximum stress in any member of a truss. The improvement consists in generalization, which is believed to be gained without sacrifice of simplicity. The graphical method of applying the criterion in the case of trusses with parallel chords has been fully treated by Professor H. T. Eddy. The method here given applies without the restriction to parallel chords. The algebraic statement of the same criterion, as given in Art. 152, is also believed to be a useful generalization of the methods hitherto used. Whether the algebraic or the graphical treatment is preferred, a method is useful in proportion to its generality, provided this does not involve a loss of simplicity. There is a decided advantage in the use of a single general equation applicable to any member of any truss, instead of several particular equations, each applicable to a special member or to a special form of truss." That this generalization will be cordially welcomed and availed of by the profession may safely be predicted.

Part III. gives graphic methods of determining centers of gravity and the moments of inertia of plane areas, with a discussion of inertia-curves, carried as far as the practical engineer will ordinarily need. Eight clear, double-page plates complete the work, and one's only regret in viewing them is that they cannot face the text describing them, to the saving of the student's time and temper.

We notice that the author uses a term, 'complanar' (whether he suggests it or not is not evident), which we trust will not supplant the generally accepted 'con-plane,' which is consistent with the other equally self-explanatory terms con-focal, con-axial, etc., and needs no modification.

The book is a thoroughly good one preëminently for the class-room, and a course in it should be a pleasure alike to pupil and instructor. FRED'K N. WILLSON.

PRINCETON UNIVERSITY.

GENERAL.

PROFESSOR MARTIN'S books on *The Human Body* are in many ways models in the presenta-

tion of a difficult subject. We are glad to receive 'The Briefer Course' (Holt), revised by Professor G. W. Fitz, of Harvard University, and to commend it cordially. The book has been corrected throughout and a chapter added on growth and nutrition. The three apendices, which occupy nearly one fourth of the book, are all open to criticism. They are on 'Emergencies,' 'Alcohol and Tobacco' and 'Demonstrations and Experiments.' 'Emergencies' make up part of the examination in physiology which may be taken for entrance to Harvard College, but it is not evident that a school boy will profit intellectually or practically by being told how to treat apoplexy. The demonstrations and experiments, also part of the Harvard examination, may in their present form be useful for the teacher, but scarcely for the student. The reviser states that the appendix on narcotics is retained against his judgment. The injurious effects of narcotics must by foolish laws be taught in most public school courses on physiology; but it would be possible to prepare a statement that would be scientifically correct, even though its teaching might be ethically obnoxious. The statements in this book are not exactly incorrect, but they would produce false impressions on young students. The results of excess are pictured, and the boy is left to infer that the final state of his father, who drinks a glass of wine for dinner, will be delirium tremens. But the boy will be more likely to conclude that physiology is not an 'exact' science.

MINERVA, 'A Yearbook of the Learned World,' is indispensable to the editor and useful to every one who wishes to keep informed on the progress of education and science. As is well known, the book contains accounts of universities, libraries, museums, learned societies, etc., throughout the world. The names of over 25,000 officers of these institutions are given, and with an accuracy that is truly remarkable. The eighth volume, 1899, which reaches us from Messrs. Lemcke and Buechner (12 Broadway, New York City), is thoroughly revised from official sources, and is enlarged and improved in several respects, including the addition of a number of Canadian institutions. Programs of the various international scientific congresses are promised for next year. The importance of the great universities of the world cannot be judged from the number of students, as the data are not comparable, but in this respect the order of the first ten is given as follows: Paris, 12,047; Berlin, 10,306; Madrid, 6,143; Vienna, 5,710; Naples, 5,103; Moscow, 4,461; Budapesth, 4,407; Munich, 3,997; Harvard, 3,674; St. Petersburg, 3,615. As a matter of fact, Harvard, with over 5,000 students all told, is probably now the fourth in size of the universities of the world, being surpassed only by Paris, Berlin and Vienna. There are thirty universities having over 2,000 students, and, of these, nine are in the United States, four in Russia and in Great Britain, three in France, in Germany and in Austria-Hungary, two in Italy and one in Spain and in Greece.

ANOTHER useful work of reference is *Who's Who?* edited by Mr. Douglas Sladen and published by Black in London and by Macmillan in New York. It contains brief bibliographies of people talked about in Great Britain, including all the leading men of science and a complete list of the members of the Royal Society. Americans are also noticed, but only in small numbers. Presidents Gilman and Harper are included, but not President Eliot. The late Professor Marsh is the only American man of science whose name we have noted.

BOOKS RECEIVED.

Report of the Seventh Meeting of the Australasian Association for the Advancement of Science, held at Sydney. Edited by A. LIVERSIDGE. Sydney, Published by the Association. Pp. lii+1161. 10s. 6d.

Éléments de Botanique. PH. VAN TIEGHEM. Paris, Masson et Cie. 1898. 3d edition, revised and enlarged. Vol. I., pp. xvi+559. Vol. II., pp. xv+612.

The Fairy Land of Science. ARABELLA B. BUCKLEY New York, D. Appleton & Co. 1899. Pp. x+252.

How to Know the Ferns. FRANCIS THEODORA PARSONS. New York, Charles Scribner's Sons. 1899. Pp. xiv+210. $1.50.

Papers and Addresses. N. Y. State Veterinary College, 1896–1898. Ithaca, N. Y. 1898.

Die Continuität der Atomverkettung. GEORG HORMANN. Jena, Gustav Fischer. 1899. Pp. 118. Mark 3.

Text-Book of Physics—Sound. J. H. POYNTING and J. J. THOMSON. London, Charles Griffings & Company; Philadelphia, J. B. Lippincott & Co. Pp. x+163.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *American Journal of Science* contains the following articles:

Glacial Lakes Newberry, Warren and Dana, in Central New York, H. L. FAIRCHILD.

Rapid Method for the Determination of the Amount of Soluble Mineral Matter in a Soil, T. H. MEANS.

New Type of Telescope Objective especially adapted for Spectroscopic Use, C. S. HASTINGS.

Phenocrysts of Intrusive Igneous Rocks, L. V. PIRSSON.

Occurrence, Origin and Chemical Composition of Chromite, J. H. PRATT.

Influence of Hydrochloric Acid in Titrations by Sodium Thiosulphate, J. T. NORTON, Jr.

Rock-forming Biotites and Amphiboles, H. W. TURNER.

One Little Known and one Hitherto Unknown Species of Saurocephalus, O. P. HAY.

Some American Fossil Cycads, G. R. WIELAND.

THE *American Geologist* for April opens with an extended article by Professor William M. Davis on the peneplain, being a reply to an article by Professor Tarr in a previous issue of the journal. Professor Davis writes from Cannes, France. Following are articles: By Professor George E. Ladd, on the Cretaceous Clays of Middle Georgia; by Professor H. N. Winchell, on the optical characters of Jacksonite, and by Professor C. H. Hitchcock, giving an account of his observations in Australasia.

THE *Journal of the Boston Society of Medical Sciences* contains a paper by Dr. Franklin G. White on 'Blood Cultures in Septicemia, Pneumonia, Meningitis and Chronic Disease,' in which, among the conclusions reached, is that the detection of specific bacteria in the blood in cases of sepsis and pneumonia gives an unfavorable prognosis. A brief but interesting article by E. H. Bradford treats of the 'Movement of the Front of the Foot in Walking;' and Dr. John Dane follows with a 'Report of Some Studies upon the Arch of the Foot in Infancy,' showing that this arch is present in infants but is masked by a sustaining pad of fat.

THE frontispiece of the *Osprey* for February is a plate of the Hairy Woodpecker by Fuertes; the first article, 'Notes from North Dakota,' by E. S. Rolfe treats of egg collecting in the vicinity of Devil's Lake. Mr. Geo. F. Breninger has an article on 'Gambel's Quail;' and Rev. W. F. Henninger discusses 'The Scourge of Egg Collecting' in a manner perhaps a little over-zealous, but with an array of facts that merit serious consideration. The feature of the number is Dr. Gill's long letter headed 'A Great Work Proposed,' wherein he lays before the readers at some length a number of suggestions for a new history of North American birds. The publication of the *Osprey* for March brings this magazine down to date; Julia S. Robins contributes an article on Wilson entitled 'Behind the Wedding Veil,' and Witmer Stone follows with a too short paper on 'An Old Case of Skins and its Associations,' being notes on one of the earliest ornithological collections in the United States. In 'Snap Shots with Pen and Camera,' E. S. Rolfe gives us half a dozen views of birds and nests, with accompanying text. 'The Gourdheads in the Cypress Swamp of Missouri,' by Otto Widmann, tells of the habits of the Wood Ibis, gourdhead being a local name for this bird. W. B. Davis has some suggestive notes on 'Odd Actions of Birds Unexplained,' and the customary notes, editorials and reviews complete this unusually good number.

SOCIETIES AND ACADEMIES.

CHEMICAL SOCIETY OF WASHINGTON.

THE regular meeting was held on February 9, 1899.

The first paper of the evening was read by Mr. F. D. Simons, and was entitled 'The Detection of Caramel Coloring Matter in Spirits and Vinegar,' by C. A. Crampton and F. D. Simons.

The paper states that the two principal tests given in the books for the detection of caramel coloring matter are, first, the reduction of Fehling's solution, and second, the precipitation of the caramel by means of paraldehyde. Neither of these tests has given satisfactory results in the hands of the authors.

It was found that fuller's earth had a selective affinity for caramel coloring matter in spirits, while the natural color derived from wood was but slightly affected. The test is made by beating up twenty-five grams of the earth with fifty cc. of the sample to be tested, allowing it to stand for thirty minutes at room temperature, and filtering. The color before and after treament is observed by means of Levibond's tintometer or other form of good colorimeter, and the amount of color removed ascertained in this way.

The test was applied to all the samples of spirits available in the laboratory of internal revenue, positive results being obtained in all cases. A series of 40 samples known to be naturally colored gave an average of 14.6 per cent. of color removed, while 18 samples of spirit known to be colored with caramel averaged 44.7 per cent. of color removed.

The test was also applied to a few samples of vinegar, with good results.

The second paper of the evening was read by Dr. David T. Day, and was entitled 'Characteristics of Iridosmium in the United States.'

A demand has lately arisen for this material as a source of osmium, with which it is proposed to impregnate the filaments of incandescent lights, with most beneficial results as to the amount of light supplied by a given current and the increased life of the lamp. The problem of supplying a large amount of osmiridium is a most fascinating one and has led to much study in the localities of the West where platinum metals have been found. The results show that platinum is much more generally distributed through the western placer mines than was supposed and that there are localities containing so-called crude platinum, in which osmiridium is found. A sample sent from the Oregon beach contained as high as 99 per cent. of osmiridium. The Hay Fork District, in Trinity county, California; Junction City, and more especially the whole Pacific Coast beach, is a most interesting field of search because the platinum is mixed with much osmiridium. It can be said in general that nearly all the crude platinum sand contains osmiridium in greater or less quantity, according to the analyses of a great number of sands made by Dr. Waldron Shapleigh, for the Welsbach Light Company. An interesting exception is the Granite Creek District, of British Columbia. A curious form of osmiridium was noted at the Chapman Mine, near Junction City, California, where nuggets ½ inch in diameter, when treated with warm dilute nitro-hydrochloric acid, yield platinum in solution and flakes of osmiridium. The separation of the platinum from the osmiridium is readily accomplished by means of nitro-hydrochloric acid, and the separation of osmic acid from the residue is quite simple by the ordinary process of passing chlorine over the osmiridium mixed with salt. The purification of the osmic acid is now effected by redistillation, but it is probable that these methods will be much improved within the next few months. It is probable that 2,000 ozs. of the material will be obtained during 1899.

The last paper of the evening was read by Dr. Day, and was entitled 'Uses of Fuller's Earth as a Filtering Medium.'

In 1892 an effort was made by the Owl Cigar Manufacturing Company at Quincy, Florida, to manufacture brick from a peculiar cream-colored clay found on their property. Instead of baking hard, it exfoliated in a peculiar manner and caused some comment from an Alsatian cigar-maker in the employ of the company, who noticed this clay and called attention to its close resemblance to German fuller's earth. This led to an inquiry as to its value as fuller's earth, at a time when the lubricating oil companies were looking for domestic fuller's earth to replace animal charcoal as a means of lightening the color of lubricating oils by filtration. The earth proved very suitable, and its use extended in this direction as well as to some extent in the bleaching of vegetable oils. But for the latter purpose the imported fuller's earth is still approved. The number of samples of clays which have been called fuller's earth and sent to the consumers for examination since that date is almost beyond belief. It has been shown that fuller's earth is quite widely scattered in the northwestern counties of Florida and the adjacent counties of Georgia. In the latter region the fact that it grades into chalcedony makes it more probable that the fuller's earth is a chemical precipitate, and this is further indicated by the replacement of calcium car-

bonate by the silica in many shells found associated with the fuller's earth.

The Florida and English fuller's earth differ greatly in appearance and to some extent in chemical composition. English fuller's earth has found its analogue in the material discovered at Fairburn, near Rapid City, South Dakota, and Valentine, Nebraska. It is altogether probable that further developments will make the material from these places an important article for use in bleaching cotton-seed oil. There is an interesting difference in the methods of testing the Florida fuller's earth as compared with the English. It is the constant practice of the lubricating oil companies simply to fill large, slightly conical cylinders with the fuller's earth, ground to about 40 mesh, through which the oil is filtered at about the temperature equal to that of boiling water. At first the filtrate is perfectly colorless and, strange to say, lighter in specific gravity and more fluid than the unfiltered oil, a fact which will probably be made use of in chemical separations of the future. Dr. Day is now using this in investigating oils. Fuller's earth is used for bleaching refined, golden cotton-seed oil to a light straw color. When the resultant is to be used for white products, such as lard substitutes, the fuller's earth is ground to a fine powder and stirred into the oil slightly above the temperature of boiling water. After a thorough mixing by agitation for a few moments the bleached oil is simply filtered through bag presses. Perhaps the most interesting feature of this use of fuller's earth is the very slight difference in the two varieties of fuller's earth in regard to their bleaching capacity, which leads to their acceptance or rejection. Little regard is paid to chemical analysis, but the tests made by filtration, on a small scale, are most severe."

WILLIAM H. KRUG.

GEOLOGICAL CONFERENCE AND STUDENTS' CLUB OF HARVARD UNIVERSITY.

Students' Geological Club, February 28, 1899. In considering the 'Law of the Migration of Divides,' Mr. J. M. Boutwell developed this law as stated by Cambell (*Journal of Geology*, IV, 580), and discussed the amendment to it which has been offered by Smith (18th Annual Report, U. S. Geological Survey, Part II., 472).

Mr. H. T. Burr described 'A Drainage Peculiarity in Androscoggin, Maine.' Androscoggin Lake, the last of a chain which drain into Androscoggin River near North Leeds, Maine, contains a unique delta, which is situated, not at the head of the lake, but at the outlet.

The preglacial valley which the lake occupies is blocked just below the foot of the lake by glacial débris, which forces the outlet stream to flow backward, against the slope of the country, into the Androscoggin. Thus the fall between the lake and the Androscoggin is so small that at times of flood this main river rises so high as to reverse the flow of the outlet stream. At such times a flood of mud-laden water pours into the lake and deposits its load. Under normal conditions the outflow is incompetent to remove the material thus brought in. Accordingly the delta has grown, and is still growing, against the normal course of the current.

Geological Conference, March 7, 1899. Professor J. E. Wolff communicated his discovery of 'Hardystonite, a New Mineral from Franklin Furnace.' The specimen of ore containing the mineral came from a new working of the Parker Shaft, at about the nine-hundred-foot level. The mineral is tetragonal, and its general formula is $ZnCa_2Si_2O_7$. A complete description will be given in the Proceedings of the American Academy of Arts and Sciences.

Dr. Charles Palache described 'A Method of Enlarging Diagrams,' which has been developed in the Harvard Mineralogical Laboratory within the last few months. It purpose is for preparing large diagrams, from small, straight-line, text diagrams, for lecture use. The instrument used is a megascope made by Fuess. This consists of two sets of three mirrors, which concentrate light upon the diagram. From that the light is reflected through a double-convex lens, which projects the image upon a screen. The diagram is then obtained by tracing the image, thus enlarged to any desired size, and by inking in this tracing. This method possesses a double advantage over photographic enlargements in that it affords a far more satisfactory product and is much cheaper.

Dr. A. S. Eakle presented 'Notes on Some Rocks from the Fiji Islands.' The collection, which included both igneous and sedimentary rocks from about twenty of the smaller volcanic islands, was made by Mr. Alexander Agassiz during his recent studies in that region. The specimens of eruptive rocks were found to include hornblende andesites, augite andesites, hypersthene andesites and basalts.

J. M. Boutwell,
Recording Secretary.

TORREY BOTANICAL CLUB, JANUARY 25, 1899.

Dr. N. L. Britton presented a report on the progress of the New York Botanical Garden, with exhibition of photographs. Dr. Britton said that during 1898 the species cultivated in the Garden at Bronx Park have reached 2,110, a gain of 700 on the previous year. The fruticetum, on the plain northeast of the Museum building, was begun in October, and now includes 195 species. The arboretum has been increased to 178 species, including those native to the tract. A viticetum is in preparation, to be planted next spring, including rock-ledges, and a rustic arbor about 600 feet long, now nearly completed. An additional nursery space near the southern corner of the tract was prepared in the spring, and planted partly with Siberian cuttings. Border screens are now planted around the entire tract except to the south. A complete record of all plants grown is kept by means of a card catalogue. From every plant which flowers on the ground an herbarium specimen is made; and these are classified in a special herbarium, useful already in satisfying inquiries. The use of the greenhouse on the Columbia University grounds at Morningside Heights was granted in 1896, and is still very important to the Garden. This is the old greenhouse built in 1857 by Mr. S. Henshaw for the Bloomingdale Asylum, and is one of the oldest greenhouses still standing in the United States.

Progress on the Museum building has been active, and it is thought it will be ready for occupation by midsummer. The Power House is nearly ready to put into operation. A subway from this to the Museum is under construction. A stable, toolhouse, etc., have been finished. The range of horticultural houses is planned to contain 13 houses; the contract for 7 of these has been signed, and ground was formally broken for them on January 3, 1899. Important work has been done toward improving the drainage of the Herbaceous Grounds, and a great deal of grading, and the terraces about the Museum have been begun. The Lorillard Mansion is now used as a police station-house, occupied by more than 65 officers, making a new and wholesome water-supply necessary. This has now been finished.

The Hemlock Forest remains in healthy condition; only three trees have died in the last three years.

The Museum is planned to provide in the basement a lecture-room seating 900; on the first floor a collection of plant-products, with models and photographs; on the second, a scientific collection for expert use, including a mounted collection of the local flora on swinging panels; followed by herbarium and laboratories on the top floor.

The herbarium already includes 30,000 specimens. Through the liberality of Mr. Cornelius Vanderbilt, Mr. and Mrs. Heller are now making collections in Porto Rico. Messrs. P. A. Rydberg and Ernest Bessey made collections in 1897 in Montana, through the liberality of Mr. W. E. Dodge. The results will soon appear as a Flora of Montana, forming the first volume of the Memoirs of the New York Botanical Garden.

E. S. Burgess,
Secretary.

DISCUSSION AND CORRESPONDENCE.

SOME SUGGESTIONS FOR SCIENTIFIC SEMINARS AND CONFERENCES.

To the Editor of Science: I feel that an experience of several years as a respectful and regular listener to scientific papers by young and old students, at college seminars or conferences, and at annual or periodic meetings of societies, gives me the basis for certain generalizations, without leaving me open to the criticism of judging from insufficient data.

The principal generalization I should like to offer is to the effect that our scientific students in colleges and professional schools do not re-

ceive sufficient training in the public presentation of their ideas, whether those ideas be original or borrowed. Most advanced scientific students in our colleges are obliged to attend and take part in seminars or conferences, at which their colleagues and teachers are supposed to criticise any scientific papers that may be presented. So far as my experience goes, the criticism is apt to be almost wholly as to scientific accuracy, with but little thought of several other points that are of vital importance. I fear teachers and professors are too apt to tolerate poor order, poor English and a 'dead-and-alive' manner of speaking, thinking the unfortunate beginner will gain wisdom by experience.

Judging from my own experience and the comments of others, I would say that our scientific workers often fail to carry their point and to win public sympathy for their work and cause because in their public utterances they do not follow rational lines of procedure. They are very apt: (1) to present an unorganized and apparently unrelated series of facts—their plan is rambling; (2) not to choose and emphasize the important points, probably because of lack of training in measuring the comparative worth of facts; (3) to use poor and inexcusable English; (4) to speak in a dazed sort of way, as though they themselves were not thoroughly convinced, as yet, of the truth of their results; (5) not to address the audience, a map or a blackboard under their influence being as inspiring as the audience, and much less embarrassing; (6) not to divide their time so as to complete their presentation within reasonable limits, thus causing weariness and restlessness on part of audience; (7) not to make good use of illustrative material in the way of maps, diagrams, specimens, lantern slides, etc.

Now the remedy for these serious failures that few men can outgrow seems to me to be largely in the hands of our college and scientific school teachers, and I would like to see a plan adopted in college seminars that would not allow a student to appear before his colleagues and masters until his plan of procedure had been censored, along the lines I have suggested, by some one of experience in public utterance. The student should also receive criticism after his paper, so as to bring out the weak points in his argument or manner, thus minimizing the possibility of an equal failure at his next appearance. Such criticism does not kill individuality, but strengthens it, and certainly gives the student a greater confidence in and respect for his teachers. Should our colleges and scientific schools uniformly adopt such a method of training, our scientific gatherings ten years hence would not be so largely composed of specialists and those who attend from duty and with considerable sacrifice. It would also be much easier to secure public support for scientific work were more of our leaders able to win the interest of the public, without becoming merely 'popular lecturers,' by whom scientific accuracy is apt to be sacrificed for the sake of impressiveness.

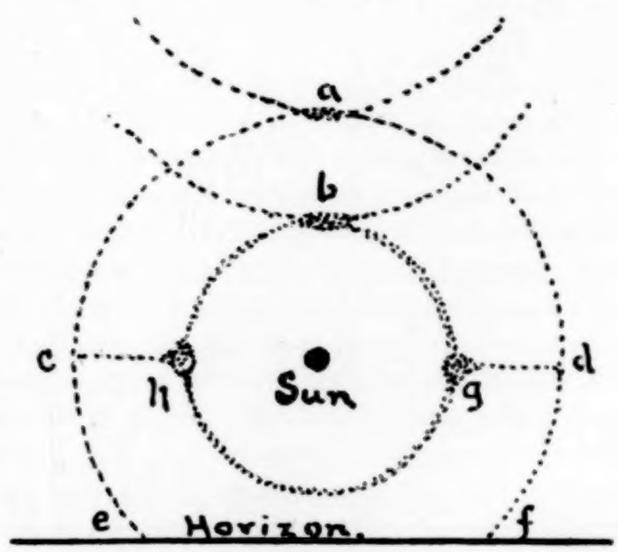
Such work as I have suggested for our teachers takes much time and energy and seems at first not to pay; but immediate returns are not always the best, and there is no work on the part of a teacher that can give greater satisfaction in the long run than that which has helped beginners to make the most of their latent powers.

RICHARD E. DODGE.

TEACHERS COLLEGE,
COLUMBIA UNIVERSITY.

A REMARKABLE SUN-DOG.

THE appended diagram is an attempt to record the appearance presented by a rare and remarkable 'sun-dog' seen at Hamline, Minnesota, at 9:50 a. m., on February 10th. It was a very



cold and damp morning; the air was not clear, and there was a film of thin clouds over all the sky. The weather records at St. Paul Observatory, five miles distant from Hamline, indicated, S. E. 6 miles per hour for the wind, 29.50 as the Barograph reading of the barometric pressure, and 20 degrees below zero as the thermograph reading of the temperature. The two 'sun-dogs' proper were *g* and *h* of the figure and were so brilliant that it was painful to look at them, and a line of intense light stretched from them outwards toward *d* and *c*. There were two circles surrounding the sun; one, the inner one, was complete; the other was nearly so, but dipped below the horizon. There were arcs of two circles turned from the sun at *a* and *b*, and at these points there was a display of prismatic colors. The large outer circle looked much like a rainbow, especially near the horizon. This latter fact seemed connected with the fact that there was almost moisture enough in the air to constitute a very fine snow.

H. L. OSBORN.
HAMLINE UNIVERSITY, ST. PAUL, MINN.,
February 20, 1899.

DEGREES IN SCIENCE AT HARVARD UNIVERSITY.

HARVARD UNIVERSITY conferred for the first time last year the degree of 'Master of Science.' As the creation of this degree appears at first sight to be a new recognition of science, it may be desirable to point out that there are aspects under which it is, in fact, harmful to science and a retrograde movement in that university to which we look for guidance. It is, indeed, logical to have a degree between the S. B. and S. D. parallel to the A. M., but it would be equally logical and, in my opinion, far better to abolish the S. B. and S. D.

The composition of the Lawrence Scientific School of Harvard University is not made less heterogeneous by giving all its graduates the same degree. Some of the students are pursuing studies in applied science exactly parallel to those of the schools of medicine, law and theology, and should on graduation be given a technical degree signifying the profession that they have been trained to practice, *i. e.*, C.E., civil engineer, etc. Others of the students are following the same scientific studies as may be elected by students of the college who receive the A.B. The difference is that the Lawrence Scientific School may be entered with an inadequate preparation. Fortunately, plans have been adopted that will gradually raise the requirements for admission to the Scientific School to substantial equality with those of the college. At present consequently the S. B., in its sense of a liberal education based upon science, means, as compared with the A. B. for the same studies, an inadequate preparation; later it will signify a secondary education without Latin.

Students of Harvard College, as of the Great English universities, may now take the A.B. without any study of Latin or Greek at the University. This freedom of election has, as President Eliot points out in his last annual report, maintained at Harvard the relative numerical importance of the traditional degree better than in any other American institution. The A.B. is becoming almost obsolete in our great State universities. Thus at California last year among 191 bachelors only 30 were in arts, at Wisconsin among 173 only 13, etc. I regard this as unfortunate as the Ph.B. and S.B. at these universities means simply a liberal education without Greek or without Latin and Greek. It seems to me more consistent to give the A.B. for liberal studies as is done at Harvard, Johns Hopkins, Columbia, Cornell and the English universities. But of these universities only Cornell is sufficiently logical to admit that a liberal education is possible without 'small Latin' in the preparatory school. President Eliot will anticipate the course of educational progress, as he has so often done, if he will transfer the required study of English to the preparatory school, as he aims to do, and will secure the admission of students to Harvard College without Latin. The S.B., S.M. and S.D. would then be superfluous as degrees for liberal studies. I regard them as useless altogether, except that it might be desirable to give the Sc.B., simultaneously with a technical scientific degree and to maintain Sc.D. and Litt.D. as honorary degrees. In the English universities Sc. refers to science, while B.S. and M.S. refer to surgery, consequently Sc. rather than S. should be used.

At Harvard the A.M. and the Ph.D. are

given for advanced work to Bachelors of Arts, and the S.D., and since last year the S.M., to Bachelors of Science. The S.D. is given for exactly the same, scientific research and study as the Ph.D., and means the same thing, except that it is in addition a certificate of a poor preparatory education. It is no wonder that it is not popular, having been awarded only once in the past three years, while the Ph.D. has been awarded sixty-nine times. If a student comes to Harvard from a Western university, having studied Latin throughout his college course and received a Ph.B., he is apparently not eligible for the Ph.D. What would be done with a student coming with the A.B. from Cornell, but never having studied Latin, I do not know. The maintenance at Harvard of the S.M. and S.D. as second-rate degrees appears to be a needless limitation of the usefulness of its graduate school, and a wounding of science in the house of its friends.

J. MCKEEN CATTELL.

COLUMBIA UNIVERSITY.

SCIENTIFIC APPOINTMENTS UNDER THE GOVERNMENT.

WE have received notice of civil service examinations as follows:

On May 9th for Assistant Chief, Division of Agrostology, Department of Agriculture. (Salary $1,800 per annum.) The subjects and weights are as follows:

1. Agrostology..60
2. Replies to letters on agrostology...................10
3. German and French translation...................10
4. Botany (major), or Chemistry (minor), (See Section 67, 'Assistants, Department of Agriculture, Departmental Service,' page 45 of the Manual of Examinations, revised to January 1, 1899).........20

At the same time an examination will be held for the position of Assistant in the Division of Agrostology at a salary of $1,200. The subjects and weights being:

1. Agrostology. 50
2. Translation from one foreign language (Spanish, French, German, or Italian)..............................15
3. Latin translation 5
4. Botany (minor), (See section 67, 'Assistants, Department of Agriculture, Departmental Service,' page 35 of the Manual of Examinations, revised to January 1, 1899)...15
5. Education and experience 15

On May 1st an eligible register will be established for the position of Irrigation Expert, office of Experiment Stations, Department of Agriculture, at a salary of $2,500 per annum. Subjects and weights are as follows:

1. A statement of the education, training and technical experience of the competitor..................30
2. A statement of the competitor's experience as an administrative officer, with special reference to irrigation laws and regulations.................................30
3. A thesis of not less than three thousand words on a topic relating to irrigation 20
4. A statement of not more than three thousand words setting forth a plan of irrigation investigations in the arid regions of the United States for the benefit of the farmers of those regions.............................20

It will not be necessary for applicants to appear at any place for examination, but the statements and theses required may be prepared by the competitors at their homes upon forms which will be furnished by the United States Civil Service Commission upon request. Competitors will be required to furnish sworn statements as to the integrity of the work submitted by them.

Under similar conditions and on the same day an eligible register will be established for the position of tobacco expert to the Department of Agriculture. The subjects and weights are as follows:

1. Experience, including complete statement of personal experience in connection with the development of the tobacco industry of Florida.........................30
2. Administrative ability, including a full statement of personal experience in the administration of work connected with the growth, purchase, manipulation and marketing of the Florida tobacco..........30
3. Two theses, of two thousand to four thousand words in length, on subjects relating to the tobacco industry...40

On May 9th and 10th an examination will be held for the position of computor in the Nautical Almanac office, the subjects and weights being:

1. Algebra 15
2. Geometry..10
3. Plane and spherical astronmy...................20
4. Elements of differential and integral calculus 10

5. Logarithms 25
6. Spherical astronomy 20

Further information regarding these positions and blanks for applications may be obtained from the U. S. Civil Service Commission, Washington, D. C.

SCIENTIFIC NOTES AND NEWS.

THE National Academy of Sciences will hold its stated annual meeting, beginning on Tuesday, April 18th.

AT the annual meeting of the Astronomical Society of the Pacific on March 25th the second award of its Bruce Gold Medal was announced. It was conferred upon Dr. Arthur Auwers, of Berlin.

SIR WILLIAM TURNER, professor of anatomy in the University of Edinburgh, has been elected President of the British Association for the Bradford meeting of 1900.

IT is announced that Mr. Llewellyn W. Longstaff, a member of the Royal Geographical Society of London, has contributed $125,000 towards the fund for the British Antarctic expedition.

DR. L. L. HUBBARD has resigned the position of State Geologist of Michigan. The *American Geologist* states that he has taken this action owing to the delay of the State Board of Auditors in authorizing the publication of the Reports of the Survey.

DR. E. V. WILLCOX has resigned his position as zoologist and entomologist in the Montana Agricultural College and Station to accept a position in the office of Experiment Stations in the place of Dr. F. C. Kenyon, resigned. Dr. Willcox will have charge of the departments of zoology, entomology and veterinary science of the *Experiment Station Record.*

MR. LE GRAND POWERS, of Minnesota, has been appointed Chief Statistician in charge of agricultural statistics, and Mr. William C. Hunt, of Massachusetts, has been given charge of the statistics of population in the twelfth census. Mr. Hunt held the same position in the census of 1890. Mr. Powers is Chief of the Minnesota Bureau of Labor.

M. FILHOL has been elected an associate of the Paris Academy of Medicine in the place of the late Dr. Worms. M. Filhol is a member of the Paris Academy of Sciences, and has published important memoirs in anatomy, zoology and paleontology.

PROFESSOR LUIGI CREMONA, professor of mathematics at the University of Rome, and Professor Alexander Karpinski, St. Petersburg, Director of the Russian Geological Survey, have been elected foreign members of the Belgian Academy of Sciences.

DR. T. GRIGOR BRODIE, lecturer on physiology at St. Thomas's Hospital Medical School, has been nominated by the Laboratories Committee of the Royal Colleges of Physicians and Surgeons to be Director of the Research Laboratories on the Thames Embankment.

MR. E. E. GREEN, the well-known Ceylon entomologist, has been appointed Government Entomologist on the staff of the Agricultural Department of that island, with residence at the Royal Botanic Gardens, Peradeniya. He is about to visit England, and will return to Ceylon to take up his work about September. For many years Mr. Green has been doing admirable work on the insects of Ceylon, with especial regard to injurious species, and a better selection could not have been made for the new position.

DR. WALTER R. HARPER, of Sydney, New South Wales, starts this month on a trip in the New Hebrides to investigate the somatology and folk-lore of that group. We are informed by him that the museums of Australia, although new, have already secured some remarkable collections representative of Australian ethnology. The museum at Sydney, under the curatorship of R. Etheridge, and the one at Adelaide in charge of Dr. Stirling, are especially good owing to the interest of their curators in ethnology. Lately the Western government sent a collecting party into the interior under the leadership of Mr. Alex. Morton, Curator of the Tasmanian Museum. This expedition was successful and secured among other things a series of carved bull-roarers, which are sacred objects there. Lack of funds hampers the work in Australia as elsewhere, and the field is yet largely unknown. Much valuable material remains to be investigated even in the Eastern

colonies, while Northwest Queensland is especially rich.

Mr. Hjalmar Lundbohm, of the Geological Survey of Sweden, is now in the United States, with a view to studying the deposits of iron ore.

Dr. Benjamin M. Duggar, instructor in botany (plant physiology) at Cornell University and Assistant Cryptogamic Botanist of the Experiment Station, sailed on March 22d from New York for Europe. He will spend the year abroad in study, principally with Dr. Pfeffer in the laboratories for plant physiology at Leipzig, and with Dr. George Klebs. He will attend the meeting of the British Association for the Advancement of Science during September. Mr. Duggar received the degree of Doctor of Philosophy at Cornell University last June. He will return in a year to resume his work at Cornell.

A marble bust of the late I. H. Lapham, the geologist, was, as we learn from the *American Geologist*, unveiled in the public museum of Milwaukee on March 7th. It was presented by Mr. John Marr. Several addresses were made, including one on the life and work of Lapham by Mr. John Johnston.

A monument to Pasteur will be unveiled and a Pasteur Institute opened at Lille on April 9th.

A monument will be erected in October to Charles Marc Sauria, said to be the original inventer of lucifer matches, at St. Lothair, a small village in the Jura, where he spent his life as a country physician.

Dr. Angelo Knorr, docent in the Veterinary School of Munich, died on February 22d, from acute glanders contracted in the course of an experimental research on mallein.

Miss Elizabeth Brown, of Cirencester, England, who made valuable contributions to astronomy, died on March 6th. She observed the total eclipses of the sun in 1887, 1889 and 1896, and had published both scientific and popular accounts of the solar phenomena.

We regret also to record the deaths of Dr. Wilhelm v. Müller, professor in the Institute of Technology and member of the Academy of Sciences of Munich; of Dr. Friedrich v. Lühmann, the mathematician, at Stralsund; of Dr. Charles Fortuun, the mineralogist, in London, and of P. v. Alfr. Feuilleaubois, known for his researches on fungi, at Fontainbleau.

A Reuter dispatch, dated March 16th, states that the steamer 'Southern Cross' has arrived at Port Chalmers from Victoria Land, where she landed M. Borchgrevink and the other members of the Antarctic expedition. The explorers are 11 in number.

Mr. A. W. Anthony and his party, who have been making collections for the Smithsonian Institution, have been wrecked off the coast of Lower California. No lives were lost, but the collections could not be saved.

The Union Pacific Railway offers to transport geologists and paleontologists without charge from Chicago or San Francisco to Wyoming, for the purpose of making explorations during the coming summer.

An expedition under Lieutenant Koslow is being sent by the Russian Geographical Society to make explorations in Central Asia. It will cross the Nanschu Mountains and explore the upper waters of the Yellow River.

M. H. R. Dumont has left to the Paris Society of Geography a travelling fund that will yield 1,000 fr. per annum.

A radiographic institute has been opened at Madrid under the direction of Dr. Mezquita. It is said to have cost $400,000.

The French Congress of Learned Societies met at Toulouse on April 4th under the presidency of M. Levasseur.

At the March meeting of the French Astronomical Society M. Cornu made an address on the applications of physics to astronomy. M. Flammarion, the Secretary, reported that a number of astronomers had written saying that they had seen the phases of Venus with the naked eye, the possibility of which has been denied. The air throughout Europe has been unusually clear for a long time.

The first international congress of physicians connected with life insurance companies will be held at Brussels from the 25th to the 30th of next September. All Europe and the United States will be represented at this congress,

which proposes to establish universal formulas for the examination of persons desiring to be insured.

ON March 18th the Austrian Society of Engineers celebrated its jubilee in the Municipal Council Chamber, Vienna, under the presidency of Mr. F. Berger. *Nature* says that there was a large attendance of members, and representatives of sixty six kindred societies presented addresses. Congratulatory speeches were delivered by the Austrian Minister of Railways; the Minister of Commerce; the Governor of Lower Austria; the Secretary of the Iron and Steel Institute, London; the Secretary of the French Society of Civil Engineers, Paris, and the Secretary of the Society of German Engineers, Berlin. A paper was then read by Mr. A. Rücker on the part taken by the Austrian Society of Engineers in the technical progress of the past fifty years. The Austrian Society is a very influential one. At its foundation in 1848 it numbered seventy-nine members; at the present time there are 2,388.

THE inaugural course of the Charles F. Deems lectureship foundation will be given by Professor James Iverach, D.D., of Aberdeen, on Mondays and Wednesdays at 10:30 a. m., beginning on April 3d at University Building, Washington Square. The endowment of $15,000 given by the American Institute of Christian Philosophy to the New York University provides for lectures on science and philosophy in their relation to religion.

MR. RITCHIE, President of the British Board of Trade, received at the House of Commons on March 22d a deputation of representatives from the Decimal Association, chambers of commerce, educational institutions and trade unions, who urged upon the government the compulsory adoption of the metric system of weights and measures on January 1, 1901. The importance of this measure was urged by Sir Samuel Montague, Sir Henry Roscoe, Sir E. S. Hill and others. Mr. Ritchie in reply said that the government had done much by making the metric system legal and by introducing it in the schools, but did not think that public opinion warranted its compulsory adoption. The resolutions passed by the associated chambers of commerce was as follows: "That, in view of the time wasted in teaching a system of weights and measures which, according to the First Lord of the Treasury, is 'arbitrary, perverse and utterly irrational,' and in the opinion of Her Majesty's Consuls is responsible for great injury to British trade, this association urges Her Majesty's government to introduce into and endeavor to carry through Parliament as speedily as possible a bill providing that the use of the metric system of weights and measures shall be compulsory in this country within two years from the passing of the bill, and suggests that meanwhile the system should be adopted in all specifications for government contracts."

THE Eclipse Expedition to Japan under Professor Todd, two years ago, founded at Esashi a public library, in return for courtesies shown the expedition. Professor Todd is now sending to this library, through the legation at Washington, a collection of books part of which have been given by a number of representative American publishers.

THE original manuscripts of surveys of Van Diemen's Land, made between 1821 and 1836, were sold recently at the rooms of Messrs. Hodgson, London, for $250.

THE Companie Générale Transatlantique is establishing a service of carrier pigeons, which it is believed will announce the arrival of steamships twelve hours earlier than is at present possible.

Nature states that a dinner which took place at the Fishmongers' Hall on March 14th possesses especial interest on account of the fact that it was given in honor of science, and that the guests included a great number of scientific men, among them being the Presidents of the following societies and scientific bodies: Royal, Royal Horticultural, Royal College of Physicians, Royal Geographical, Dermatological, Royal Microscopical, Victoria Institute, Royal Statistical, Royal College of Surgeons, Royal Astronomical, Zoological, Linnean, Chemical, Entomological, Philological and Clinical. The toast of the evening was 'Science,' and was proposed in an eloquent speech by the Prime Warden, Mr. J. A. Travers, who pointed out the great advance science had made in the last

twelve years; he recommended, further, the special study of preventive medicine, to ensure for Great Britain a safer footing in foreign climates. Lord Lister responded to the toast, and urged City Companies to support pure science; he referred also to the help they had rendered the Jenner Institute. Sir William MacCormac then proposed the health of the Prime Warden.

THE *Railway and Engineering Journal* reports that the War Department is arranging to make a test of the Marconi system of wireless telegraphy. The two experimental stations selected are the roof of the State, War and Navy Building and Fort Myer, across the Potomac, the distance being six miles. The government has purchased the necessary instruments and experiments will be conducted by Col. James Allen and Lieut. George D. Squire.

AT a recent meeting of the Royal Geographical Society a paper on 'Exploration in the Canadian Rockies: A Search for Mount Hooker and Mount Brown' was read by Professor Norman Collie, F.R.S. According to the London *Times* Professor Collie's paper dealt with two journeys taken during 1897 and 1898 through that part of the Canadian Rockies that lies between the Kicking Horse Pass on the south and the source of the Athabasca River on the north. The most interesting problem connected with the first journey which presented itself to Professor Collie and his party was whether a lofty mountain—probably 14,000 ft. to 15,000 ft.—seen from the slopes of Mount Freshfield, from which it lay distant about 30 miles in a northwesterly direction, might be Mount Brown or Mount Hooker, which were supposed to be 16,000 ft. and 15,000 ft. high respectively. Professor Coleman, in 1893, starting from Morley, had arrived at the true Athabasca Pass, found the historic Committee's Punch-bowl, and his brother had climbed the highest peak on the north, presumably Mount Brown. This peak he found to be only 9,000 ft. The question presented itself: Could he have been mistaken or was it possible that there existed two Athabasca Passes? Professor Collie and his companion returned to their camp on the Saskatchewan Pass without having solved the question of either Mounts Brown or Hooker, or the Committee's Punch-bowl. It was finally settled on the return to England by reference to the journal of David Douglas, the naturalist, dealing with his journey over the Athabasca Pass. From the authentic account of the two mountains there given it was seen that the credit of having settled with accuracy the real height of the peaks belonged to Professor Coleman. For nearly 70 years they had been masquerading in every map as the highest peaks in the Rocky Mountains. No doubt now remained as to where Brown and Hooker and the Punch-bowl were. That Douglas climbed a peak 17,000 ft. high in an afternoon (as narrated in his account) was impossible; the Mount Brown of Professor Coleman, 9,000 ft. high, was much more likely. There was only one Athabasca Pass, and on each side of its summit might be found a peak—Mount Brown, 1,000 ft. high, on the north—the higher of the two—and Mount Hooker on the south. Between them lay a small tarn, 20 ft. in diameter—the Committee's Punch-bowl. The peaks to the south, amongst which the party wandered last August, were, therefore, new, and they probably constituted the highest point of the Canadian Rocky Mountain system.

THE *British Medical Journal* states that the tenth meeting of the International Congress of Hygiene will be held in Paris in August, 1900. The division of hygiene will comprise seven sections as follows: 1. Microbiology and Parasitology applied to hygiene. M. Laveran is President and M. Netter Secretary of this Section, in which the questions to be discussed are the measurement of the activity of serums; the prophylaxis and preventive treatment of diphtheria; meat poisoning, its causes and the means of its prevention; pathogenic microbes in soil and water (cholera, typhoid fever and other diseases); the part played by water and by vegetables in the etiology of intestinal helminthiasis. 2. Chemical and veterinary sciences applied to hygiene; alimentary hygiene, in which the questions to be discussed are tinned provisions and the means of preventing accidents; unification of international control; the establishment of a general and uniform system of inspection of slaughter houses, etc. 3. En-

gineering and architecture applied to hygiene, in which the question to be discussed is the protection of water supplies. 4. Personal hygiene, in which the question to be discussed is contagious patients from the hospital point of view. 5. Industrial and professional hygiene. 6. Military, naval and colonial hygiene, in which the question to be discussed is the means of ensuring the purity of water from the point of view of colonial hygiene. 7. General and international hygiene (prophylaxis of communicable diseases; sanitary administration and legislation), in which the questions to be discussed are the prophylaxis of tuberculosis in regard to individuals, families, etc.; the compulsory notification of communicable diseases, its necessary consequences (isolation, disinfection) and its results in different countries; the prophylaxis of syphilis; and the international prophylaxis of yellow fever.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. JOHN D. ROCKEFELLER has offered $100,000 to Denison University, Granville, O., if the friends of the institution will, within the next year, raise the sum of $150,000.

MRS. SIMON REID, of Lake Forest, has expressed her intention of giving to Lake Forest University a chapel and a library.

THE further sum of £25,000 has been offered for the Birmingham University on condition that £225,000 are obtained within a year. The amount already promised is £135,000.

PROFESSOR LOUIS F. HENDERSON, professor of botany in the University of Idaho, at Moscow, Idaho, has recently donated to the botanical department of Cornell University a complete set of his duplicates of the phanerogams and ferns of Idaho. Over 900 species were contained in the collection, making it one of the most valuable single local collections that the University has received. Professor Henderson is an alumnus of Cornell University, class of '74.

PROFESSOR W. v. BRANCO, of Hohenheim, has been called to the chair of geology and paleontology in the University of Berlin, as successor to Professor Dames.

CHARLES EDWARD ST. JOHN, PH.D., has been appointed to the professorship of physics and astronomy in Oberlin College.

MR. JOSEPH BARCROFT has been elected Fellow of King's College, Cambridge. His chief work has been in physiology.

ALEXANDER ANDERSON, professor of natural philosophy in Queen's College, Galway, has been appointed President of the institution.

IT is said that the candidates for the chair of physiology at Edinburgh, vacant by the death of Professor Rutherford, include Professor E. A. Schäfer, Dr. William Stirling, Dr. D. N. Paton, Dr. E. Waymouth Reid, Dr. E. W. W. Carlier and Dr. G. N. Stewart.

M. HENRI MOISSAN has published for the Council of the University of Paris a report on its work during the year 1897-8. The increase in the number of students at periods of six years is shown in the accompanying table:

	1885-86.	1891-92.	1897-98.
Medicine	3.696	4.250	4.494
Law	3.786	4.111	4.607
Pharmacy	1.767	1.547	1.790
Letters	928	1.185	1.989
Sciences	467	655	1.370
Protestant Theology	35	36	95
Total	10.679	11.784	14.346

It will be noticed that the growth in the number of students of science is the greatest, and the increase has been more than maintained during the present year, being 127 as compared with 85 in letters. It should be recollected that there are many important institutions for higher education in Paris—The Collège de France, The Museum of Natural History, The School of Mines, the Normal College, The Polytechnic Institute, The School of Fine Arts, The Pasteur Institute, etc.—not included in the University. Paris is thus certainly the world's largest educational center, but the provincial universities are less important than the corresponding institutions in other countries. The gifts to the university during the year, about $30,000, appear small in comparison with those to American institutions. There are only 202 scholarships, which is also relatively fewer than in America and in Great Britain.